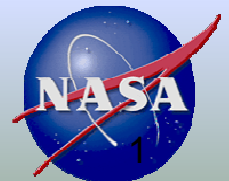


Precipitation Constellation Progress Report

Steven Neeck
NASA Headquarters
Riko Oki
JAXA

September 14, 2011



Activity Status



✓ **PC activities by 2011-2013 Precipitation Constellation Work Plan (in process of finalization and confirmation)**

- ❑ Joint activities
 - ❑ Mission Operation and Development
 - ❑ Linkages to User Communities
 - ❑ PC Framework
 - ❑ Data exchange
 - ❑ Cal/Val
 - ❑ Algorithm and Products
 - ❑ Meetings and Workshops
- ❑ Individual PC deliverables
 - ❑ Hardware; Satellite, sensor, data-distribution systems
 - ❑ Software; Algorithm development/improvement, data-processing, products
 - ❑ Applications
 - ❑ Meetings

✓ **In addition, there are four 2011 CEOS-GEO Actions**

- ❑ Two Category-1 Actions
 - ❑ AR-09-02a_38, AR-09-03a_39
- ❑ Two Category-2 Actions
 - ❑ AR-09-02a_36, CL-09-02b_3
- ❑ One action closed (CL-09-02b_3). Progress being made on remaining three actions
- ❑ Provided update on status to SIT Chair and CEOS Executive Officer

Activity Status (cont.)



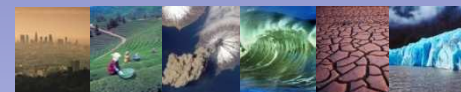
- ✓ **Study of conical scanning microwave imagers (MI) availability**
 - ❑ Completed final report
 - ❑ Available to PC Agencies by end of September
- ✓ **Developing plans for PC data portal**
 - ❑ Completed mockup
 - ❑ Further steps on implementation will be discussed at the upcoming CEOS PC Workshop
- ✓ **CNES/ISRO M-T/GPM cooperation**
 - ❑ NASA-CNES IA signed, NASA-ISRO IA ready for signing
- ✓ **NOAA GPM cooperation**
 - ❑ Draft MOU being finalized
- ✓ **INPE/AEB/GPM cooperation**
 - ❑ Review of draft IA continuing
- ✓ **Progress in GPM implementation**
 - ❑ Well along in Core Spacecraft integration and test, DPR environmental testing completed, GMI integration completed and environmental testing underway
 - ❑ DPR unaffected by Great Tohoku Earthquake but testing was delayed
 - ❑ GMI and DPR instruments planned for delivery early next year
 - ❑ Completed Precipitation Processing System (PPS) Build 3 Design and Implementation Review
- ✓ **Implemented improved TRMM algorithm (Version 7)**
- ✓ **UNCOPUOS**
 - ❑ Provided update to report on Space-system-based Disaster Management

Activity Status (cont.)



- ✓ **AR-09-02A: Virtual Constellations Task Sheet**
 - ❑ Provided update
- ✓ **Provided inputs to CEOS SIT Self Study (review of draft VC Report)**
- ✓ **Supporting review of MIM Measurements database**
- ✓ **Field Campaigns**
 - ❑ LPVEX Ground Validation experiment (NASA, FMI, Environment Canada) data available on GPM GV website (<http://gpm.nsstc.nasa.gov/index.html>)
 - ❑ Completed Mid-Latitude Continental Convective Clouds Experiment (MC3E): NASA-DOE field campaign and data available on GPM GV website (<http://gpm.nsstc.nasa.gov/index.html>)
 - ❑ Planning for GPM Cold-season Precipitation Experiment (GCPEX): GPM-Environment Canada campaign on snowfall retrieval, Ontario, Canada, Jan-Feb 2012
- ✓ **CEOS Meetings/Workshops held**
 - ❑ 2011 CEOS-GEO Actions Workshop, February 16-17, 2011, Arlington, VA, USA
 - ❑ SIT-26, May 24-25, 2011, Frascati, Italy
- ✓ **Meetings/Workshops held**
 - ❑ X-Calibration Working Group (WG) (in coordination with CGMS/GSICS), October 21-22, 2010, Asheville, NC, USA
 - ❑ Precipitation Measuring Missions Science Team, November 1-4, 2010, Seattle, WA, USA (NASA)
 - ❑ 4th Joint Precipitation Science Team Meeting, November (5, 2010, Seattle, WA, USA (NASA, JAXA)
 - ❑ X-Calibration Working Group (WG) (in coordination with CGMS/GSICS), March 1-2, 2011, College Park, MD, USA
 - ❑ X-Calibration Working Group (WG) (in coordination with CGMS/GSICS), July 13-14, 2011, Fort Collins, CO, USA

Activity Status (cont.)



✓ **Meetings/Workshops in planning**

- 9th GPM International Planning Workshop, deferred to 2012
- Precipitation Measuring Missions Science Team, November 7-10, 2011, Denver, CO, USA (NASA)
- 5th Joint Precipitation Science Team Meeting, November 11, 2011, Denver, CO, USA (NASA, JAXA)
- 4th CEOS Precipitation Constellation Workshop, November 10, 2011, Denver, CO, USA (hosted by NASA)
- Precipitation Measuring Missions Science Team, 2011 winter (TBD), Tokyo, Japan (JAXA)
- 3rd GPM Asia Workshop on Precipitation Data Application Technique (hosted by JAXA) in conjunction with 2nd Asia-Oceania Meteorological Satellite Users Conference (hosted by JMA), December 7-9, 2011, Tokyo, Japan

✓ **Documents in finalization and confirmation**

- 2009-2010 Precipitation Constellation Accomplishments
- 2011-2013 Precipitation Constellation Work Plan

✓ **Future remaining activities and milestones**

- Near term plans are defined in 2011-2013 Precipitation Constellation Work Plan
- Long term plans are articulated in CEOS Precipitation Constellation 10-year Implementation Plan

✓ **Main Issues**

- No new issues – see p.12 for statement of current/future challenges

Activity Status (cont.)



✓ Main 2011 Achievements/Outcomes

- ❑ Enhancement of the Precipitation Constellation Space Segment
 - Progress on GPM instrument (DPR, GMI) and Core Spacecraft development (NASA, JAXA)
 - Progress towards Megha-Tropiques launch (CNES, ISRO)
 - Formalization of Megha-Tropiques and GPM cooperation (NASA, CNES, ISRO)

- ❑ Progress towards completion of 14 years of TRMM 3-hr, multi-satellite standard products (TMPA, 3B42) (November 2011). See <ftp://trmmopen.gsfc.nasa.gov/pub/merged>.

- ❑ Implementation of improved TRMM algorithm (Version 7)(August 2011). See <http://trmm.gsfc.nasa.gov>.

- ❑ Study of the availability of conical scanning microwave imagers (MI) in the late-GPM Phase and the Post-GPM Phase of the Precipitation Constellation (October 2011 release)

- ❑ Improvements in inter-satellite calibration techniques through the X-Cal WG. See <http://www.gpm-x-cal.info/>

Near Future Plan



✓ **Additional Expected Achievements by the end of 2011**

- Continued GPM space and ground segment development progress
 - Completion of GMI environmental testing (NASA)
 - Completion of DPR Pre-Ship Review (JAXA)
 - Completion of spacecraft bus box integration (NASA)
- Launch and early operations of Megha-Tropiques (ISRO, CNES)
- Signing of NASA-ISRO Megha-Tropiques/GPM cooperation IA
- Release of study of conical scanning microwave imagers (MI) availability
- Completion of 14 years of TRMM operations (NASA, JAXA)
- Completion of GCPEX field campaign preparations
- Completion of remaining three 2011 CEOS-GEO Actions
- Completion of 4th CEOS Precipitation Constellation Workshop
- Continued progress on PC Data Portal

✓ **Contribution to 2011 Events (e.g., GEO-VIII, COP-17)**

- No specific contribution planned

✓ **Information on any decisions that need to be made at CEOS Plenary**

- No specific decision requested



Backup

Goals of the Precipitation Constellation



To establish an international framework to guide, facilitate, and coordinate the continued advancements of multi-satellite global precipitation missions

- 1) To provide a framework for implementation and monitoring of GEO task AR-06-10

Advocate and facilitate the timely implementation of the Global Precipitation Measurement (GPM) mission and encourage more nations to contribute to the GPM constellation

- 2) To sustain and enhance an accurate and timely global precipitation data record including a Fundamental Climate Data Record essential for understanding the integrated weather/climate/ecological system, managing freshwater resources, and monitoring and predicting high-impact natural hazard events.

This data record should be fit for the purpose specified by GCOS for the monitoring of Precipitation as an essential climate variable (ECV) (as defined in the recent GCOS document 'Systematic Observation Requirements for Satellite-based Products for Climate')

2011 CEOS-GEO Actions



AR-09-02a_36 Conduct study of the availability of conical scanning microwave imagers (MI) in the late-GPM Phase and the Post-GPM Phase of the Precipitation Constellation.

AR-09-02a_38 Continue progress in instrument and spacecraft manufacturing and testing for GPM implementation, advancing GPM science algorithms through ground validation experiments, and partnership building with space agencies to contribute additional microwave sensors and satellites to the GPM constellation. Action is necessary to realize GPM Phase of Precipitation Constellation.

AR-09-02a_39 Continue TRMM operations through 2011. Action is necessary to support GPM Preparatory Phase of the Precipitation Constellation.

CL-09-02b_3 Evaluate and implement improved TRMM algorithm.

Availability of Microwave Imagers in the Post-GPM Era PC study



- *“It is clear that the post 2018 time period does not have as many imagers as even the current CEOS PC prototype era. It is recommended that CEOS recommend to current providers of imagers that they make additional contributions of imagers to the post-GPM era CEOS PC.” – Pre-release report conclusion*

Current/Future Challenges



- *Formalizing international agreements on GPM participation*
- *Enhancing high-sensitivity light and solid precipitation measurement capability in polar latitudes*
 - *No clear path forward following unsuccessful proposal of ESA EE-8 Polar Precipitation Mission (PMM)*
- *Enhancing precipitation measurement capability in low and mid latitudes*
 - *To improve utility of GPM data for hydrological applications and near-realtime monitoring of hurricanes and mid-latitude storms*
 - *Necessitated by NASA's cancellation of GMI-2 and suspension of NASA-INPE joint LIO study*
- *Increasing the availability of Microwave Imagers in the post-GPM era*
 - *Apparent shortage compared to current PC (study pre-release conclusion)*
 - *GCOM-W sustainment and DWSS/post-EPS crucial (study pre-release conclusion)*
- *Exploring opportunities to include additional space-based and ground assets from other nations to augment the next generation PC (e.g. the possible use of Russian or Chinese radiometers)*
 - *PC made contact with Director of SRC PLANETA, follow-up visit planned for October*
 - *CMA participating at working level in X-Calibration Working Group*
- *Continued support for open data sharing through CEOS and/or GEO*

Participation



- Study Lead Agencies:
 - Japan – JAXA: Riko Oki, oki.riko@jaxa.jp & USA – NASA: Steven Neeck, steven.neeck@nasa.gov
- Space Agency Participants:
 - France - CNES: Didier Renault, didier.renaut@cnes.fr
 - India - ISRO: V. Hegde, vshegde@isro.gov.in
 - Brazil - INPE: Carlos Frederico Angelis, angelis@cptec.inpe.br
 - Europe - ESA: **VACANT**
 - China – NSMC/CMA: **VACANT**
 - Russia – ROSHYDROMET: Vasily Asmus, asmus@planet.ittp.ru
 - USA - NOAA: Ralph Ferraro, ralph.r.ferraro@noaa.gov
 - USA - Naval Research Laboratory: Ian Adams, ian.adams@nrl.navy.mil
 - Europe - EUMETSAT: Johannes Schmetz, Johannes.Schmetz@eumetsat.int
 - Germany - DLR: Martin Hagen, martin.hagen@dlr.de
 - Canada - Canadian Space Agency: Luc Brule, Luc.Brule@asc-csa.gc.ca

Participation (cont.)



- User Community Representatives:
 - CGMS-IPWG: George Huffman, george.j.huffman@nasa.gov
 - GEWEX: Chris Kummerow, kummerow@atmos.colostate.edu
 - WCRP/IGWCO: Rick Lawford, lawford@umbc.edu
 - GCOS: Paul Mason, p.j.mason@reading.ac.uk
 - Peter Bauer, Peter.Bauer@ecmwf.int
 - Phil Arkin, parkin@essic.umd.edu



U.S. Study Team

- Steven Neeck/NASA HQ
- Ramesh Kakar/NASA HQ
- Arthur Hou/NASA GSFC
- Bob Adler/ UMBC
- Erich Stocker/NASA GSFC (SEO POC)
- Scott Braun/NASA GSFC (Visualization POC)
- Ralph Ferraro/NOAA
- Joe Turk/JPL
- Ian Adams/NRL
- Chris Kummerow/Colorado State University

Japan Study Team



- Riko Oki, JAXA
- Masahiro Kojima, JAXA
- Kinji Furukawa, JAXA (SEO POC)
- Keizo Nakagawa, JAXA
- Misako Kachi, JAXA (Visualization POC)
- Toshiaki Takeshima, JAXA
- Kengo Aizawa, JAXA
- Keiji Imaoka, JAXA
- Kazuo Umezawa, JAXA
- Kenji Nakamura, Nagoya University
- Toshio Iguchi, NICT
- Ken'ichi Okamoto, Osaka Prefecture University
- Toshio Koike, University of Tokyo
- Jun Matsumoto, Tokyo Metropolitan University
- Kazuhiko Fukami Public Works Research Institute
- Yoshiaki Takeuchi, Japan Meteorological Agency
- Yoshiyuki Chihara, Ministry of Education, Culture, Sports, Science and Technology

Action: AR-09-02a_36 Description



Status: **OPEN**

Action: AR-09-02a_36

Category #: 2

Point of Contact: Steven Neeck, Riko Oki

Due Date: 15/5/2011

Lead Agency: NASA, JAXA

Other Agency and Organization Participation: NOAA, EUMETSAT

CEOS Working Group and Constellation Participation: PC

Action Description

- Conduct study of the availability of conical scanning microwave imagers (MI) in the late-GPM Phase and the Post-GPM Phase of the Precipitation Constellation
- Major near-term milestones are:
 - Report to be made available to PC Agencies in September 2011 with final report provided to SIT by October 2011.

Action: AR-09-02a_36 Status



- The final report which shall include planned MI assets and their compatibilities as well as missing key MI assets (including required capabilities) will be completed by August 2011. The study shall include all possible MI assets including those from agencies not currently participating in the CEOS PC.
- Prepared final report following receipt of Roshydromet Satellite Program information. Revised milestones reflecting delays in Roshydromet information receipt and report finalization.
- Revised deliverables and milestones are:

September 5, 2011: Delivery of the report to CEOS PC leads

September 30, 2011: Delivery of report to CEOS PC members

October 15, 2011: Final approval of report and submission to SIT



Action: AR-09-02a_38 Description

Status: **OPEN**

Action: AR-09-02a_38

Category #: 1

Point of Contact: Steven Neeck, Riko Oki

Due Date: 1/12/2011

Lead Agency: NASA, JAXA

Other Agency and Organization Participation: NOAA, EUMETSAT, INPE, CNES, ISRO

CEOS Working Group and Constellation Participation: PC

Action Description

- Continue progress in instrument and spacecraft manufacturing and testing for GPM implementation, advancing GPM science algorithms through ground validation experiments, and partnership building with space agencies to contribute additional microwave sensors and satellites to the GPM constellation. Action is necessary to realize GPM Phase of Precipitation Constellation.
- Major near-term milestones are:
 - "Conduct MC3E Field Campaign (NASA, DOE)(2Q2011) - COMPLETED
 - Complete GMI-1 instrument Pre Environmental Review (NASA)(3Q2011) - COMPLETED
 - Implement a NASA-CNES-ISRO agreement on Megha Tropiques-GPM cooperation (4Q2011)
 - Implement a NASA-INPE agreement on GPM cooperation (4Q2011)
 - Hold GPM International Planning Workshop (2015) and 4th CEOS Precipitation Constellation Workshop (4Q2011)
 - Ship DPR instrument (KaPR and KuPR PFM) for integration on the Core Spacecraft (JAXA)(1Q2012)
 - Ship the GMI instrument for integration on the Core Spacecraft (NASA)(4Q2011)
 - Complete Core Spacecraft Bus integration and testing (NASA)(4Q2011)
 - Integrate DPR and GMI instruments on Core Spacecraft bus (NASA, JAXA)(1Q2012)
 - Prepare for GPM Cold-season Precipitation Experiment (GCPEX) field campaign (NASA, Environment Canada)(4Q2011)

Action: AR-09-02a_38 Status



- Completed six week MC3E field campaign in Oklahoma, USA on June 22.
- Completed GMI instrument Pre-Environmental Review on July 19-20.
- NASA completed negotiations on the NASA-CNES-ISRO agreements on Megha Tropiques-GPM cooperation. The agreements are being finalized for signing in October.
- Revised milestone date on NASA-INPE agreement on GPM cooperation reflecting continuing review by the US and Brazil of the draft Implementing Arrangement.
- Rescheduled the GPM International Planning Workshop to 2012 and location and 4th CEOS Precipitation Constellation Workshop to November 10 in Denver, Colorado, USA due to impact of March Great Tohoku Earthquake in Japan.
- Revised DPR instrument shipment date due to impact (facilities damage) of March Great Tohoku Earthquake in Japan and hardware development issues.
- Revised DPR and GMI integration on Core Spacecraft date due to instrument delivery delays.
- NASA and Environment Canada finalizing Letter of Agreement for GCPEX.



Action: AR-09-02a_39 Description

Status: **OPEN**

Action: AR-09-02a_39

Category #: 1

Point of Contact: Steven Neeck, Riko Oki

Due Date: 31/10/2011

Lead Agency: NASA, JAXA

CEOS Working Group and Constellation Participation : PC

Action Description

- Continue TRMM operations through 2011. Action is necessary to support GPM Preparatory Phase of the Precipitation Constellation.
- Major near-term milestones are:
 - March 4, 2011: Submission of TRMM mission extension proposal to NASA ESD Senior Review Panel – COMPLETED
 - May 3-5, 2011: 2011 Senior Review Panel Meeting – COMPLETED
 - September 30, 2011: NASA ESD Senior Review guidance on mission extension, allowing for the completion of 14 years of TRMM 3-hr, multi-satellite standard products (TMPA, 3B42), through December 31, 2011.

Action: AR-09-02a_39 Status



- The TRMM Senior Review Proposal was submitted in March and evaluated in the May 3-5 Senior Review Panel Meeting. The panel's report was published on July 26 for use in developing the NASA Earth Science Division (ESD) guidance on TRMM operations in Fiscal Year 2012 and beyond per the planned September milestone. The report recommended continued funding of TRMM operations in US Government Fiscal Year 2012-2013 and that a further two years of operations be budgeted subject to review of the spacecraft's health and propellant usage by the 2013 Senior Review Panel. The report can be found at <http://nasascience.nasa.gov/earth-science/missions/operating/>. The NASA ESD guidance letter release has been slightly delayed from the beginning to the end of September.

Action: CL-09-02b_3 Description

Status: **CLOSED**

Action: CL-09-02b_3

Category #: 2

Point of Contact: Steven Neeck, Riko Oki

Due Date: 31/1/2011

Lead Agency: NASA, JAXA

CEOS Working Group and Constellation Participation: PC

Action Description

- Evaluate and implement improved TRMM algorithm
- Major near-term milestones are:
 - June 30, 2011 Implement Version 7 of the TRMM standard algorithms - COMPLETED
 - August 15, 2011 Reprocessing and public release of the Version 7 standard products - COMPLETED

Action: CL-09-02b_3 Status

- Version 7 algorithm in development (January 2009). Rescheduled deliverable milestones to reflect delays in getting final algorithm from code developers. Using test code as workaround. Some impact from Precipitation Radar anomaly (October 2009). Completed multi-month run of Version 7 in test mode (December 2009). Began Version 7 Operational Acceptance Testing (January 2010). Operational Acceptance Testing continues. Team revised milestones to permit more thorough analysis of test data (April 2010). 2A25 algorithm testing nearly complete but revisions required 2A12 algorithm cloud database updating. Revised milestones due to this and staffing conflicts with GPM PPS Build 2 upcoming review (June 2010). Completed initial testing of revised rain retrievals algorithm code for PR and TMI retrievals. Revised milestones due to this and revised schedule for multi-year product generation and detailed science analysis of products as part of Operational Acceptance Testing (September 2010). Generated six months of all data products and distributed to selected science team members and GV group (October 2010). Testing and analysis of PR product underway with completion scheduled for spring 2011 (December 2010). Operation Acceptance Test with updated algorithm began April 15 and is scheduled to complete on June 20. JAXA and NASA formal review of Version 7 algorithm for acceptance scheduled for June 21-24. Updated milestone dates to reflect algorithm update, additional acceptance testing, and JAXA/NASA formal acceptance review (May 2011). Completed implementation of Version 7 algorithm on June 29. Completed reprocessing of all TRMM data using Version 7 algorithm on August 15. Data are available at http://trmm.gsfc.nasa.gov/data_dir/data.html. Action status is CLOSED.

PC Approach



- Develop a consistent framework to produce inter-calibrated precipitation sensor measurements and retrieval products
- Identify key points of agreement for space agency co-operation in order to meet the needs of both the data producer and user communities
- Results-focused, identifying what steps are necessary by space agencies (and other groups responsible for product generation, in-situ observations etc) to develop the constellation data sets and information services. CEOS PC should also encourage the development and evaluation of precipitation products produced from the constellation data. This should include inter-comparisons and validation against high quality ground data.
- Recognize the Constellation member's national plans for implementing their respective Earth observing programs (e.g. the U.S. Decadal Survey).
- Have strong collaboration with the CEOS Working Group on Calibration and Validation (WGCV) and the CEOS Working Group on Information Systems and Services (WGISS)

Implementation



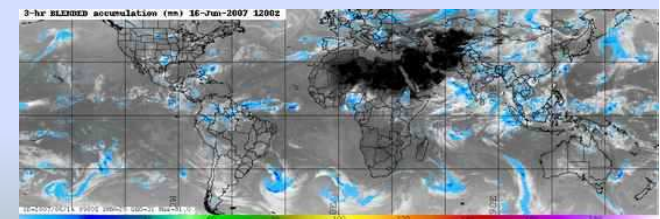
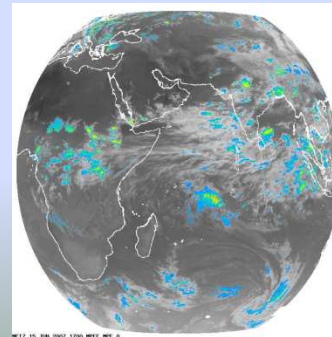
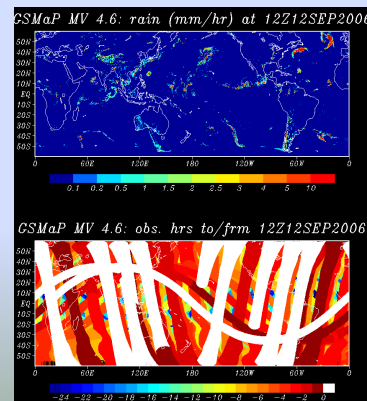
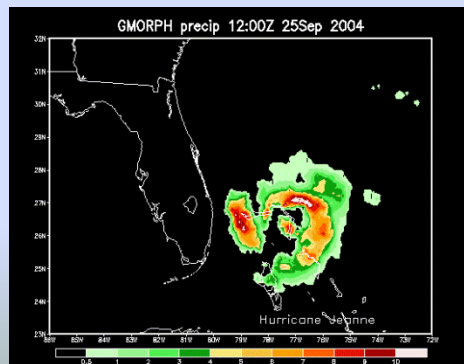
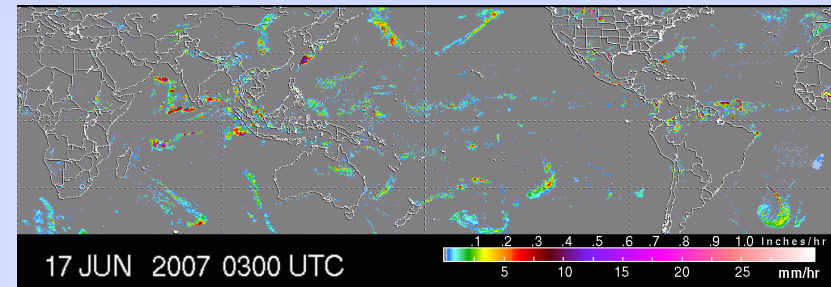
- The implementation of CEOS PC is in four phases

year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
phase	study phase	GPM preparatory phase					GPM phase					post -GPM phase	
							<div style="border: 1px dashed black; padding: 10px; text-align: center;">GPM</div>						



Phase Descriptions

- Objectives are articulated for four phases
 - Study Phase (2007)
 - Study key items which should be achieved to formulate the CEOS PC, and produce the initial Implementation Plan
 - Identify the key points of agreement for space agency co-operation in order to meet the needs of both the data producer and user communities
 - Study the existing multi-sensor activities undertaken by PC team members
 - NASA TRMM 3B42 standard product
 - JAXA GSMaP prototype product
 - NOAA CMORPH/QMORPH products
 - NRL products
 - EUMETSAT MPE product (TBC)



Phase Descriptions (cont.)



- GPM preparatory phase (2008-2012)
 - Comparison of different methods of inter-calibration for generating uniform precipitation estimates from diverse types of precipitation sensors
 - Evaluation of different multi-sensor precipitation products
 - The prototyping of uses of merged data products from multiple sensors as well as evaluation of tools to support such use
 - Establishing the standard merged precipitation products desired
- GPM phase (2013-2017)
 - Launch and operation of GPM, the first constellation-focused mission that will improve precipitation estimates through extensive intercalibration and the use of a reference standard
- Post-GPM phase (after 2017)
 - Beyond timeframe of GEOSS 10-Year Implementation Plan
 - Activities during this phase will not be specified clearly in an early stage
 - Lessons learned from GPM and other PC activities will serve to guide the planning and further evolution of CEOS PC

